Magnetism and High Potential Apparatus

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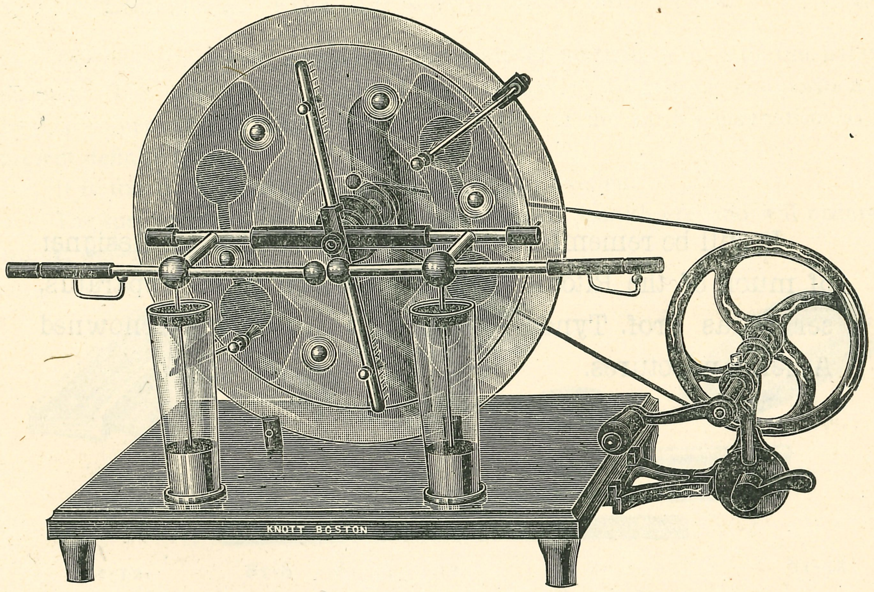

L. E. KNOTT APPARATUS COMPANY,
(INCORPORATED.)
BOSTON, MASS.

PROPRIETORS OF
E. S. RITCHIE & SON'S APPARATUS.

We manufacture the National Physics Apparatus for the Laboratory and the Ritchie Apparatus for the Lecture table.

It will be remembered that Mr. E. S. Ritchie, the designer of much of the Ritchie Standard Lecture Table Apparatus, served as Prof. Tyndall's assistant during his renowned American lectures.

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L. E. Knott Apparatus Co.
Boston, Mass.

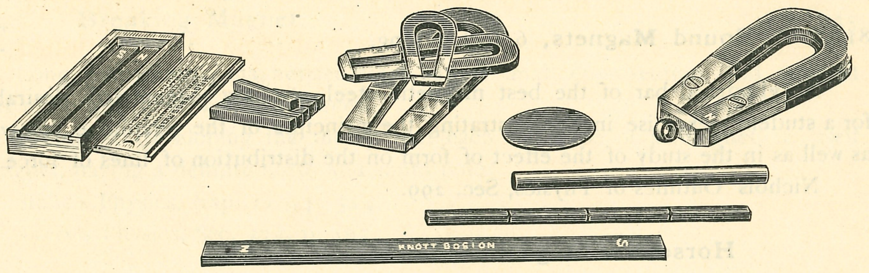
MAGNETISM.

81-2	**Lodestone.**	Selected specimen showing distinct poles, -	.50
81-4	**Lodestone.**	Extra large, selected, having distinct poles,	1.00

The logical place to commence the study of magnetism is with the natural magnet. The lodestone is a natural iron ore having a chemical composition of Fe_3O_4, so permanently magnetized by the action of the earth's magnetism as to present definite poles.

It is found at present in Arkansas, Spain and Sweden.

The specimens we furnish are the best selected Spanish ore, and will maintain strong, well-defined poles.



MAGNETS.

A good magnet must be made of steel of the right composition, and must be tempered at exactly the right temperature. Great care is necessary in the magnetization to obtain two strong, opposite poles, which increase in power uniformly from the central or equatorial point to a point near the end. Skill and care are both essential to produce the best results.

Our magnets are intelligently made, and are deserving of intelligent care. Wherever possible they should be kept in pairs with the opposite poles adjacent, and protected with a soft iron armature or "keeper." Under favorable conditions these magnets will increase, rather than decrease, in strength as time goes by.

81-8 **Bar Magnet**, 2 inches long, - - - each .20, dozen, 1.50

For satisfactory laboratory work, four should be provided for each pupil.
Gilley's Physics, p. 387.

For much of the student laboratory work this form will be found extremely valuable, as the small size makes it possible to group any desired number, showing various combinations of poles, on a single sheet of note-book size.

81-12 **Bar Magnets**, 6 inches long, each, - - .25, dozen, 2.50

For students' use in studying induction, lines of force, magnetic saturation, distribution of magnetism, etc., the two and six-inch magnets will be found most serviceable, as they come within the compass of note-book area.
Hall and Bergen, Ex. 50.

81-16 **Bar Magnet**, 12 inches long, each, - - - - - - 1.90

This is the most satisfactory size for lecture-table work.

For the study of distribution of magnetic force, use Magnetometer No. 81-68.

The law of magnetic distribution has been stated as follows: "If the space between the center and the end of a perfect bar magnet be divided into seven equal parts, the magnetic strength of these parts will be represented by numbers having the following ratio: 0 : 7 : 16 : 27 : 55 : 91 : 135 : 187."
Silvanus Thompson, Magnetism and Electricity, Sec. 134.

81-18 **Round Magnets**, 6 inches long, - - - .30

A cylindrical bar of the best magnetic steel, strongly magnetized, desirable for a student's exercise in demonstrating the principle of the telephone receiver, as well as in the study of the effect of form on the distribution of lines of force.
Nichols' Outlines of Physics, Sec. 299.

Horseshoe Magnet.

The U shape is desirable because of the increased strength, resulting from the ability to use two poles at one time. This form is frequently used in studying the mutual action of two magnetic poles.

Each magnet is provided with an armature, and with reasonable care will grow stronger with age.

		Length,	Price, each,	Price per dozen,
81-24	- - -	2-inch,	.10	.90
81-26	- - -	3 "	.15	1.25
81-28	- - -	4 "	.25	2.00
81-30	- - -	6 "	.60	
81-32	- - -	8 "	1.20	

For students' use we recommend the three-inch magnet as being most satisfactory. For lecture-table work either the four, six or eight-inch magnet will be found of sufficient strength.
Cooley's Physics, Sec. 300.

81-38 **Compound Horseshoe Magnet**, 6 inches long, - - 2.50

Two strong horseshoe magnets, superimposed and securely clamped, showing the increased magnetic strength resulting from two or more magnets placed together.

This form will be found very useful in lecture-table work requiring a greater strength of pole than can be obtained in one magnet.

81-46 **Magnetized Steel Discs**, each, - - - .50

This disc is magnetized with two distinct, clearly-defined poles, which can be readily shown either by the method of iron filings, or by the suspending of a delicately-balanced needle passed around the circumference of the disc.

This exercise leads to a clear understanding of the action of the dipping needle at various portions of the earth's surface.

The student is so accustomed to considering a magnet as a body composed of one short and one long axis, that it is desirable to use magnets of a variety of shapes. The disc form is most valuable, serving as the connecting link between magnets of ordinary shape and the spherical form, which the earth is commonly represented as being.

By using the short-needle compass No. 82-12, the magnetization of the disc may be very definitely studied.

81-48 **Breaking Magnet**, - - - - - - .15

Long, permanently magnetized steel bar of small cross-section, and grooved so as to be readily broken into pieces.

Useful for developing the theory that each molecule of a magnet is itself a magnet, having a definite north and south pole.
Stone's Physics, Exp. 126, p. 314.
Avery's Physics, Sec. 374, p. 465.

81-50 **Nickel Bar**, - - - - - - .20

Useful for showing that other substances besides iron possess magnetic properties. Under the right conditions, Cobalt, Manganese, Cerium and Chromium may be shown to have magnetic properties.

81-52 **Screens for Magnetic Transparency**, per set, - .90

For demonstrating the permeability of substances to magnetic influence.

This set is composed of squares of uniform size of zinc, iron, aluminum, glass, iron gauze and copper gauze.

The exercise leads to a more definite understanding of the reasons for using metals of a definite kind in the construction of magnetic apparatus and machines, a principle made use of in many instruments of precision.
Gage's Principles of Physics, Sec. 487, p. 521.
Silvanus Thompson, Sec. 97.

81-54 Iron Filings, per pound, - - - - .15

A most valuable adjunct to the teaching of magnetism by the laboratory method.

While iron filings are apparently easy to obtain, it must be remembered that satisfactory results can be secured only with filings which are exceptionally clean, and of uniform magnetic density.

We furnish filings selected with special reference to work in magnetism. They are soft, free from oil or dirt, and of uniform size.

81-56 Soft Iron Bar for Studying Magnetic Induction, .20

This bar is made of iron of uniform magnetic density, sufficiently soft so that the magnetic induction is very pronounced, and the quantity of residual magnetism is not perceptible.

The reason for careful selection is well explained in Silvanus Thompson, Sec. 98.

81-62 Apparatus for Arago's Experiment, (Foucault Currents)

This exercise demonstrates very clearly the fact that Foucault Currents are set up in a disc of metal, rapidly rotating between the poles of a powerful magnet, showing that even so-called magnetic transparent substances are only relatively so.

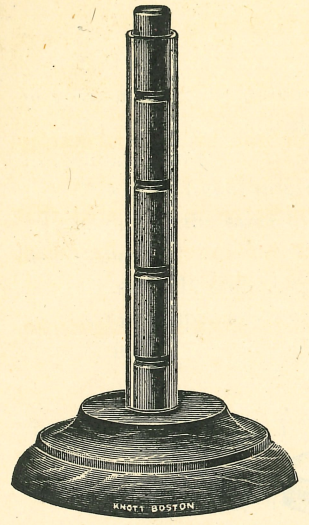
The principle is made use of in the Thompson Recording Watt-meter and other commercial instruments.

A rotating copper disc, above which is mounted a magnetic needle. The whole is arranged for attaching to our whirling table.

Watson's Physics, Sec. 523.

"Faraday's discovery of the induction of currents in wires, by moving them across a magnetic field, suggested the construction of magneto-electric machines to generate currents in place of voltaic batteries, and Faraday himself constructed the first of such machines in 1831."

P. 476. S. P. Thompson.



81-66

81-66 Woodhull's Magnetometer, for Rapid Testing of the Relative Strength of Magnetic Poles, 1.75

The term "Magnetometer" has heretofore been applied to an expensive, delicate and somewhat elaborate instrument for testing the exact strength of magnets, but with this simple instrument it is possible to measure the relative strength of magnetic poles, or of successive points in the same magnet, with a reasonable degree of accuracy.

The exercise is so simple, and the principle involved so important, that its use can hardly be dispensed with in laboratory teaching.

The instrument consists of a glass cylinder in which are loosely-fitted, carefully-cut cylinders of iron, of uniform magnetic density. In use the magnet is presented to the upper cylinder, and its relative strength is determined by the number of cylinders lifted from the tube.

Woodhull and Van Arsdale's Manual, Exp. 7, p. 65.

81-68 Vibration Magnetometer, - - - - - - 9.50

For exact study of the laws of the magnet, magnetic distribution and the moment of the earth's magnetic force.

It is constructed so that it may also be used in determining magnetic attraction and repulsion.

The box in which the needle is mounted contains a graduated scale, a needle having a long pointer, and a mirror for exact reading The fibre suspension is delicate and reliable.

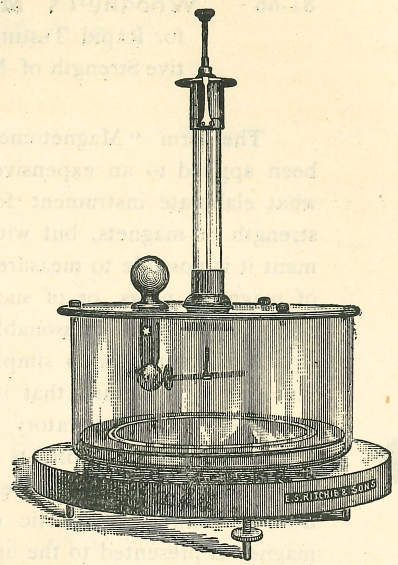
Ames and Bliss Manual, Exp. 65 & 66.

Stewart and Gee, Vol. II, Sec. 12.

"It must be remembered that it is **ether pressure** that causes all the phenomena in a magnetic field, and hence the ether pressure may be as much as 1,000 pounds per square inch." Dolbear, Nat. Philos. p. 147.

"The educational value of practical physics, is in the training it gives in attention to details, in the cultivation of accuracy in observing the smallest changes, in the formation of systematic methods of work, in developing the ability to reason back to a general law from a particular set of observations, and in cultivating habits of precise expression on the pages of a laboratory note book."

Prof. H. N. Chute.



81-70.

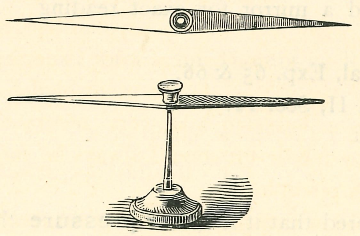
81-70 **Coulomb's Torsion Magnetometer** - - - 30.00

This instrument is made up in the form used by Prof. Coulomb with so much success, and by which much additional information concerning the magnet was obtained.

The suspension is extremely sensitive, the entire instrument being of high-grade construction, and in every way satisfactory as an accurate magnetometer.

Its glass mounting and open construction make it possible for a group of students to observe the result at one time.

Watson's Physics, Sec. 421.



82-2

82-2 **Mounted Magnetic Needle**, - - - - - .75

A magnetized needle, 4 inches long, delicately mounted on a pivot bearing, especially designed for lecture-table work. It is also used in the Oersted's Law apparatus.

Dolbear's Natural Philosophy, Sec. I, p. 114.

Cooley's Physics, Exp. 131.

82-12 **Short-Needle Compass** for testing lines of force. Per dozen, 1.80

This compass is especially designed for testing the lines of force about the pole of a bar magnet, because of its short needle and extreme sensibility.

The short and delicately suspended needle responds most freely to any change in resultant force.

It will be found interesting to place a large number of these needles about a bar magnet at the same time. The magnetic field is then presented to the students at a glance.

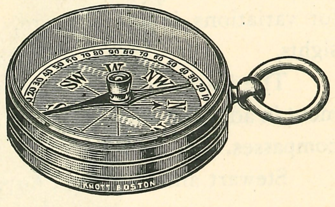
Cooley's Physics, Exp. 148.

A form especially recommended by Dr. Hall for his exercises in the study of lines of force.

82-16 **Compass**, 3 1-2 cm., brass bearing, - - - .35

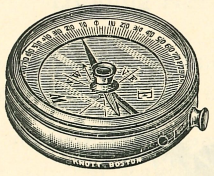
Correct size for use in the small tangent galvanometer. It is also useful in many laboratory exercises, especially in the tracing of lines of force and studying the direction of currents in a conductor.

This form of the compass is more generally used in the laboratory than any other.



82-16

82-22 **Compass with Agate Bearing** and Needle-Lift, - 1.50



82-22

A strictly high grade instrument having an agate bearing, silvered scale, fine pointed needle and needle-lift. With careful use it will remain in good condition almost indefinitely. The scale is graduated from 0 to 90.

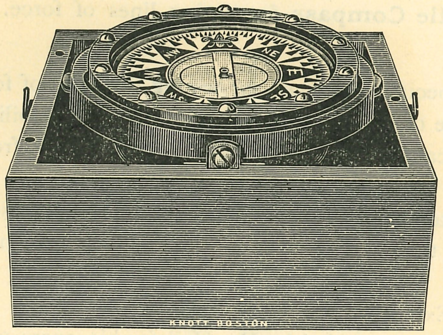
Each pivot is hardened and ground, and the mechanical work is perfect.

As the point of the needle and the scale are adjusted so closely, it is possible to take very accurate readings. When the instrument is not in use the needle-lift should always be set so as to relieve the suspension pivot as much as possible.

(Note). The end of a compass needle, or suspended magnet, pointing north is commonly called the *north pole*, but more strictly speaking it is the north-seeking pole; or, better still, as many of the foreign manufacturers designate it, the *south pole*.

To avoid confusion we place a mark on the north-seeking end, and, in use it is desirable to speak of the poles as the *marked* and *unmarked* end. This is definite, and avoids all confusion.

For a study of magnetic declination, see Ganot, Sec. 692.



82-28

82-28 **Marine Compass,** 5 inches in diameter, - - 16.00

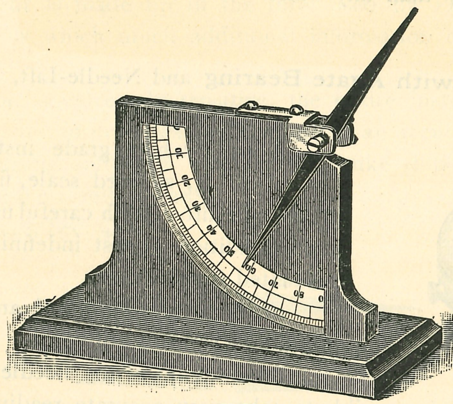
A high grade instrument, Standard for United States Navy Service.

A desirable educational instrument.

The moving system is floated in alcohol, contained in a compensating chamber for variations in temperature. It has a standard marine compass dial with line sights.

The instrument is furnished in a neat mahogany case, and is a practical instrument in addition to serving as an excellent illustration of the construction of marine compasses.

Stewart and Gee, Sec. 697.



82-36

82-36 **Dipping Needle,** - - - - - - 2.75

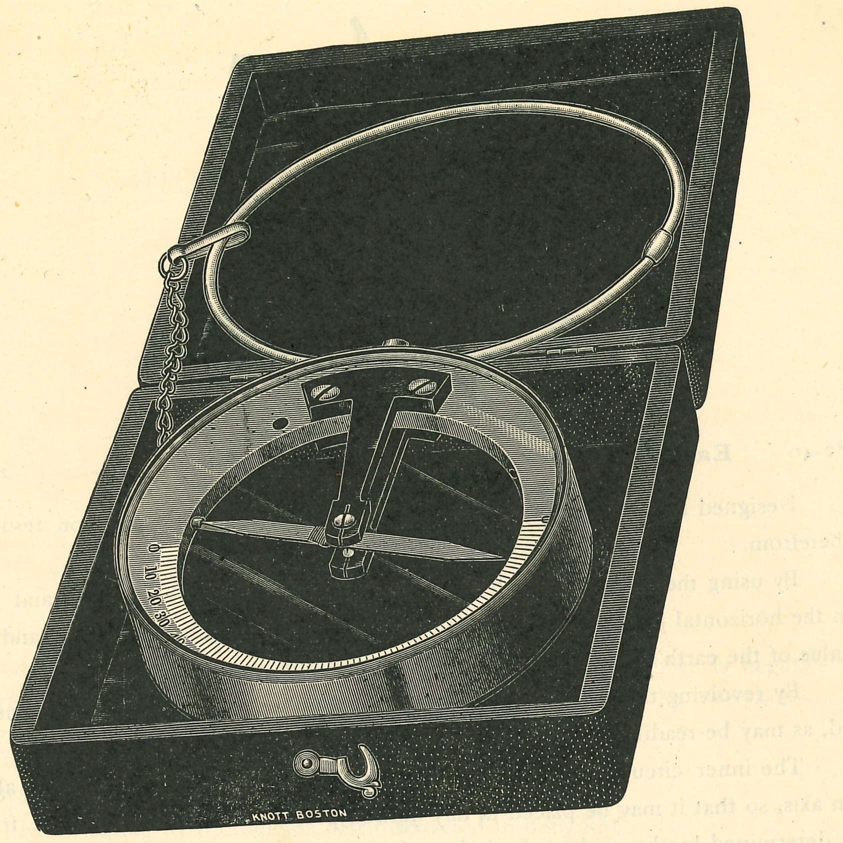
Useful in laboratory illustration. A permanent magnet four inches long, carefully balanced before being magnetized and delicately mounted on pivotal bearings.

Invaluable for the study of terrestrial magnetism.

For methods of determining inclination of the needle and the significance of inclination.

Ganot, Sec. 698.

Watson's Physics, Sec. 431.



82-38

82-38 **Dipping Needle,** Miner's Compass, - - - 12.00

A clinometer, or miner's compass, for determining the dip and quickly detecting the proximity of iron ore. The standard form used by miners.

A delicate and accurately suspended needle in brass case, 3 1-2 inches in diameter, silvered scale graduated on both sides, and magnetic stop. The double glass sides and double scale renders the readings easily taken from either side.

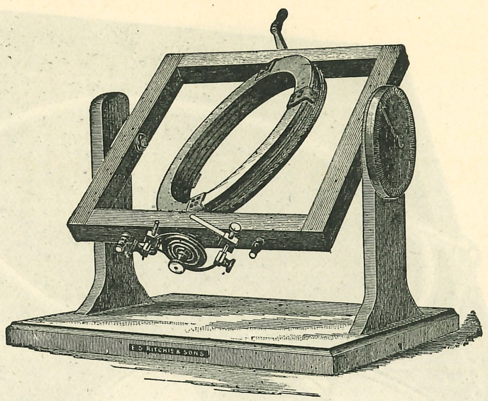
The instrument has a large, nickeled brass ring convenient for slipping over the arm in carrying. It is contained in a nicely-finished leather, plush-lined case.

Ganot, Sec. 699.

Watson's Physics, Sec. 431.

"The class instruction should be accompanied by experiments given by the teacher; such experiments being chosen as emphasize the important principles of the subject."

H. N. Chute.



82-40.

82-40 Earth Inductor, - - - - - 25.00

Designed for study of the earth's magnetic field and the induction resulting therefrom.

By using the instrument with the axis of rotation, first in the vertical and then in the horizontal position, the theoretical dip may be readily calculated, and the value of the earth's magnetism, at any particular location, determined.

By revolving the inner coil across the magnetic meridian, a current is generated, as may be readily shown with the galvanometer.

The inner circular coil is mounted in a square frame which also moves about an axis, so that it may be placed in any desired position. The angle of the frame is determined by the graduated circle and pointer. The current from the coil is led off through a commutator.

The entire instrument is adjusted for definite and exact scientific study.

Stewart and Gee, Vol. II, p. 381.

METHODS OF NAMING POLES.

Pole that points to the North, or North—Seeking.	Pole that points to the South, or South—Seeking.	
North	South	Ordinary usage
Austral	Boreal	French usage
Marked	Unmarked	Faraday
Red	Blue	Sir G. Airy
True South	True North	Sir Wm. Thompson
Positive (+)	Negative (—)	Mathematical usage

Stewart and Gee, Vol. II, p. 19.

FRICTIONAL ELECTRICITY.

GENERATORS.

83-2 Glass Rod, - - - - - - .30

Made of Scotch glass because of its accumulating power.

Glass is positively charged when rubbed with silk, while rubber is negatively charged when rubbed with cat's fur, both of which illustrate the two kinds of electrification.

Wentworth & Hill, Sec. 256, p. 273.

Thwing, Sec. 69, p. 94.

Electrification by friction was first discovered in 600, B. C.

In the following list, compiled by Faraday, the substances are arranged in such an order that each becomes positively electrified when rubbed with any of the bodies following it, but negatively electrified when rubbed with any of those which precede it.

1 Fur
2 Wool
3 Ivory
4 Glass
5 Silk
6 Metals
7 Sulphur
8 Hard Rubber
9 Collodion
10 Celluloid

83-4 Hard Rubber Rod, - - - - - - .40

Finished for most powerful results.

This rod is used in studying the laws of electro-static influence, besides serving in many experiments where the electroscope is employed. Its charge is considered negative.

Adapted for laboratory or lecture table work.

Nichols' Outlines, Exp. 61, 62, 63, 64.

Du Fay first suggested that there were two kinds of electricity, to which he gave the names of vitreous and resinous. These were first designated as positive and negative by Franklin.

83-6 **Resinous Rod, Moulded,** - - - - .20

Will permit of powerful electrification and is preferred by some to hard rubber.

Woodhull & Van Arsdale's Manual, Exp. 12, under Magnetism and Electricity.

The intensity of a charge developed by rubbing two substances together is independent of the actual amount of friction.

When two dissimilar substances are placed in contact, one of them always assumes the positive and the other the negative condition, although the amount may be sometimes so small as to render its detection very difficult.

83-8 **Silk Exciting Pad,** - - - - - - .50

Pad of pure silk; is used for electrifying glass and other substances. Made in permanent form for laboratory use.

Hoadley, Exp. 155, p. 265.

83-10 **Cat Skin, Medium,** - - - - - - .75

83-12 **Cat Skin, Extra Large,** - - - - - 1.00

Cat's fur is known to be the best to produce electrification in such substances as vulcanite, sealing wax, resin, etc. It may also be used to start a charge in the static machine.

They are large enough to be cut into four pieces for individual use.

Cooley, Exp. 112, p. 302.

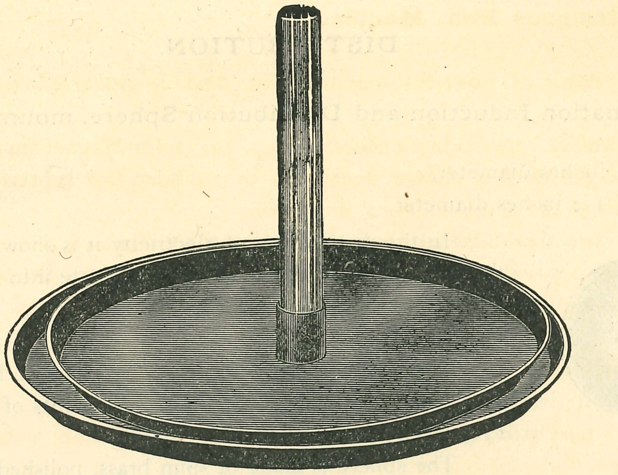
83-14 **Pith Balls,** per dozen, - - - - - .25

The simplest and best method for testing electro-static influence. They are very light and extremely sensitive.

Woodhull & Van Arsdale's Manual, Exp. 12-19 under Electricity.

"Electricity is the name given to any invisible agent known to us only by the effects which it produces, and by various manifestations called electrical. These manifestations, at first obscure and even mysterious, are now well understood; though little is yet known of the precise nature of electricity itself."

"If you take a piece of sealing wax, or of resin, or a glass rod, and rub it upon a piece of flannel or silk, it will be found to have acquired a property which it did not previously possess: viz., the power of attracting to itself such light bodies as chaff, or dust, or bits of paper. This curious power was originally discovered to be a property of amber, or, as the Greeks called it, 'elektron,' which is mentioned by Thales of Miletus (B. C. 600), and by Theophrastus in his treatise on Gems, as attracting light bodies when rubbed." Silvanus P. Thompson.



83-16

83-16 **Electrophorus,** 10 inches diameter, - - - 2.00

Will work under all climatic conditions.

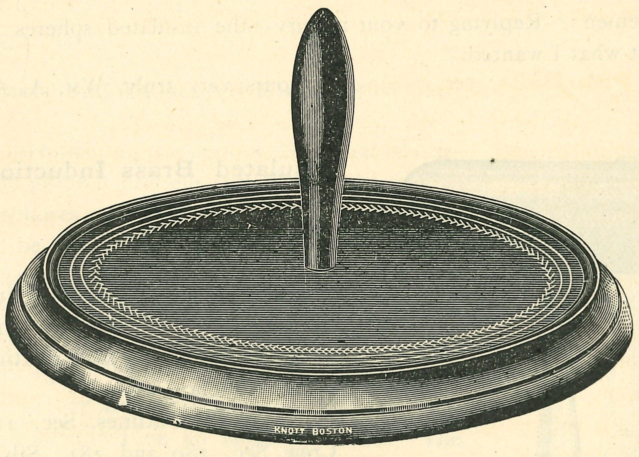
An instrument made of the best material for generating static electricity. Acting on the same principle as a static or Influence machine, it will be found very desirable for explaining how electricity is produced, condensed and discharged in those machines. May be used to charge Leyden Jars, Electroscopes, etc. (The Holtz Machine is often referred to as a continuous acting electrophorus.)

Ganot, Sec. 752; Nichols' Outlines, Sec. 204, p. 227.

To obtain best results keep the instruments dry and warm.

Thwing's Physics, p. 102.

Induction was first identified and named by John Canton, in 1753.



83-20.

83-20 **Ritchie's Lecture Table Electrophorus,** 12 in. diam., 12.00

The plate is of electro-static rubber mounted in a finished metal base. Disc of heavy brass finely finished. An instrument superior for its reliability and well adapted to lecture table work.

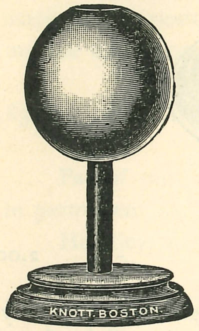
In the electrophorus the intensity of spark is directly proportional to the area of the generating surface.

For a complete theory of its action, see Silvanus Thompson's Electricity, Sec. 26.

DISTRIBUTION.

Combination Induction and Distribution Sphere, mounted, open top:

84-2	6 inches diameter, - - - - -	8.50
84-4	4 1-2 inches diameter, - - - - -	4.00


KNOTT. BOSTON.
84-4

In the distribution of electricity it is shown by this sphere that the electrification does not penetrate into the interior, but remains on the outer surface.

Ganot, Sec. 735.

The interior, however, may be charged by induction as described in Rowland & Ames' "Elements of Physics," Sec. 121, p. 135.

The sphere is made of spun brass, polished and lacquered, having a hole in the top. It is mounted on a mahogany base with insulating pillar.

As the charge is proportional to the collecting surface, the large sphere will be found to be much better adapted to lecture work.

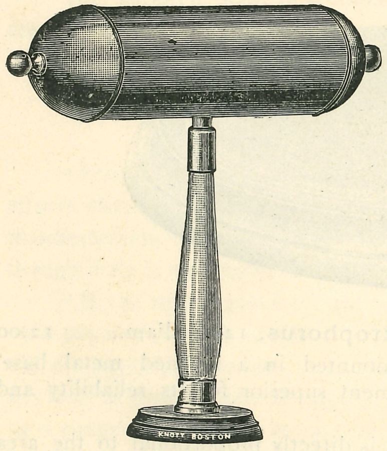
For the method of using the sphere and cylinder together for induced effects, see Silvanus Thompson's Electricity, Sec. 22.

Cooper Union, New York, N. Y., Dec. 28, 1901.

L. E. Knott Apparatus Co.,

Gentlemen :—Replying to your inquiry—the insulated spheres you made for me are just what I wanted.

Yours very truly, Wm. A. Anthony.



84-8.

Insulated Brass Induction Cylinder.

84-8	8 inches, - -	3.50
84-10	16 " - - -	10.00

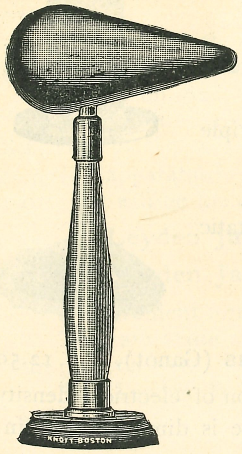
An attractive type of insulated conductor, especially adapted to the lecture table for developing facts relating to Electrostatic Influence, etc.

Nichols' Outlines, Sec. 215 and 216; Crew, Sec. 280 and 281; Silvanus Thompson, Sec. 22.

If the positively charged sphere be brought near one end of the cylinder, that end will become negatively charged while the other will be positively charged.

The large cylinder is preferred for lecture table work because the amount of electricity is directly proportional to surface.

84-16	**Ellipsoidal Conductor**, mounted, - - -	7.50



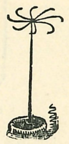
84-16

A most valuable instrument for demonstrating the tendency of static distribution, the intensity of charge increasing uniformly toward the pointed end.

Nichols' Outlines, Sec. 214; Gage's Principles, p. 447; Thompson's Electricity, Sec. 38.

It is made of finished brass, lacquered, mounted on a mahogany base with glass insulating pillar.

84-18	**Electric Whirl on Stand**, - - - -	1.25

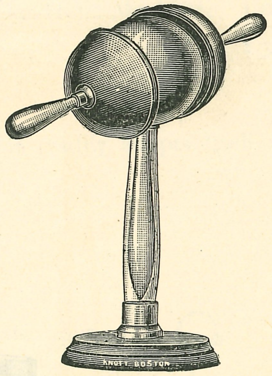

84-18

This instrument shows very beautifully the reaction caused by electricity escaping from a point into the air.

Consisting of a series of pointed metal vanes all bent in the same direction and fixed to a central brass cap, mounted to turn freely on a metal pivot attached to a wood stand.

Ganot, Sec. 764.

84-22	**Sphere and Dissected Globe, Biot**, - -	8.00



84-22

Used for investigating the laws of electro-static distribution. The globe is first electrified, then the two removable hemispheres are placed over it. Upon removing them they will be found electrified, while the inner globe has lost its charge. This shows how static electricity seeks the outer surface of a body.

Ganot, Sec. 735; Wentworth & Hill, Sec. 264; Thompson, Sec. 33.

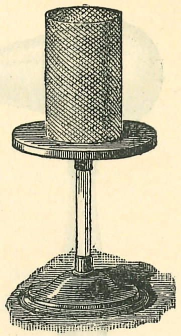
The globe is four inches in diameter, made of polished brass and mounted on an insulated stand. The removable hemispheres are also made of brass, each having an insulated handle.

84-24	**Proof Plane**, for testing electro-static charges, - -	.30

A disc of brass attached to an insulating handle. Convenient for carrying electricity from a charged body to the electrometer.

Avery's School Physics, p. 417.

84-26 **Metal Shield, or Electric Screen** (without support), 2.00



84-26

For covering the electroscope according to Faraday.

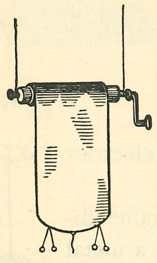
Showing the Marconi (wireless telegraph) system of selecting electric signal waves.

This serves as a most valuable illustration of the principle of protection from lightning.

Hall and Bergen, p. 499.

To be used with the electroscope and any form of static generator.

84-30 **Ritchie's Surface and Intensity Apparatus** (Ganot), 12.50



84-30

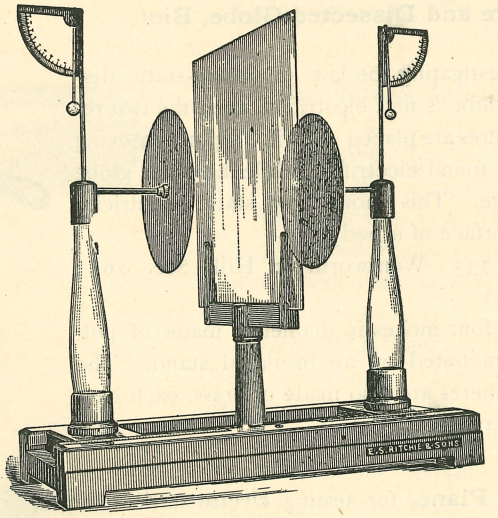
This apparatus shows the variation of electrical density on a unit of surface, as that surface is diminished or increased.

A revolving brass cylinder around which a large sheet of tin foil is wrapped, representing the surface, while a pith ball electrometer in metallic contact indicates the intensity of influence exerted by each unit of surface.

Ganot, Sec. 735

The mounting is two insulated pillars. The rotating cylinder of brass is provided with a pith ball electrometer.

CONDENSERS.



85 2

85-2 **Principle of Condenser, Dissectible,** (Epinus Model), 15.00

This apparatus is for studying the principle of condensation, and is especially adapted for showing its essential features. The arrangement is simple and easily understood.

The apparatus consists of two movable brass plates, mounted on insulating supports, between which is a mounted glass plate. Attached to each metal plate is an electrometer, indicating the density and distribution of a charge under various conditions.

Its operation shows conclusively that while electricity does not pass through glass, it readily acts across it by induction.

Thompson, Sec. 56.

A good description of the apparatus will be found in Ganot's Physics, Sec. 765.

The apparatus is very neatly made, careful attention being given to all of its parts. It will be found a valuable instrument for the lecture table.

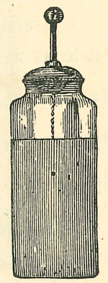
85-8 **Leyden Jar,** 1 quart, - - - - - - 1.50

85-12 **Leyden Jar,** 4 quart, - - - - - 2.30

A convenient form of condenser first used by Musschenbrœk.

They are made of Ritchie glass, known for its di-electric properties and coated with pure tin foil.

The Leyden Jar gets its name from the town of Leyden, where it was invented.



85-8

In using the discharger with a Leyden Jar, place one terminal on the outer coating while the other is brought near the ball of the jar connected to the inner coating. If the reverse is done, the tin foil on the outer coating is liable to be torn by the discharge.

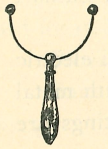
The capacity of a condenser depends upon (1) the size and form of the condensing plates; (2) the thickness of the insulating material; and (3) the inductive capacity of the insulating material.

(Note) In all work where a perfect di-electric substance is desirable, we use a special glass made from a formula long approved by E. S. Ritchie.

85-16 **Leyden Jars,** with foil for 12-in. plate Toepler-Holtz Machine, .75

85-18 **Leyden Jars,** with foil for 16-in. plate Toepler-Holtz Machine, 1.00

85-22 **Discharger for Leyden Jar,** - - - 1.50



85-22

The curved form is most convenient as it readily adapts itself to small or large jars.

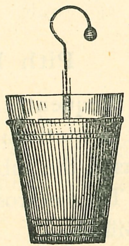
85-28 **Dissected Leyden Jar,** - - - - 3.00

For demonstrating that a charge does not accumulate upon the metal coatings, but that it resides upon the surface of the glass. This was first shown by Franklin.

Dolbear, p. 195; Hoadley, Exp. 174, p. 280.

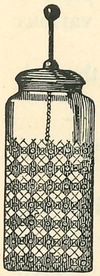
Capacity, two quarts. It is made in conical form with removable metal coatings and brass connecting rods.

This jar is made of the glass referred to above.



85-28

85-32 **Diamond Jar**, ½-gallon capacity, - - - - 3.00


85 32

A striking arrangement for showing optically the distribution of electricity over the surface of a condenser in being charged and discharged.

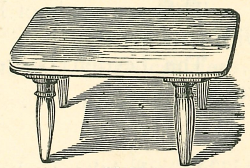
Both the inner and outer surfaces are covered with diamond shaped pieces of tin foil.

85-38 **Insulating Stool**, - - - - - - 4.00

For insulating apparatus or persons while experimenting with static electricity.

A very convenient arrangement for lecture table work. Substantial construction, insulating legs, well finished.

Useful for supporting small apparatus on the lecture table as well as large pieces on the floor.

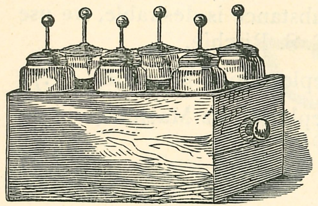

85 38

85-40 **Leyden Battery**, (2 jars) - - - - - 5.00

85-42 **Leyden Battery**, (4 jars) - - - - 9.00

85-44 **Leyden Battery**, (6 jars) - - - - - 13.00

A series of Leyden Jars whose inner coatings are connected to one terminal and the outer coatings to another, thus employing a larger area of coated surface than contained in one jar. Useful for demonstrating that the capacity of a condenser is directly proportional to the area of its coated surface. This can be shown by the greater length of time it takes to charge the battery; the more powerful spark produced by their combined discharge; or by the use of the electrometer.


85-44

Ganot, Sec. 774; Hoadley, Sec. 329; Carhart & Chute, Sec. 294.

These jars are made of selected glass especially adapted for its di-electric qualities, and coated with pure tin foil. They are placed in a box lined with metal which serves to connect the outer coatings of the jars. The inner coatings are joined in series by means of a brass chain.

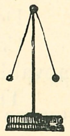
The Ritchie glass is invaluable for the best results with the Leyden battery.

ELECTROMETERS.

86-2 **Pith Ball Electrometer and Support**, - - .50

Frequently called the "electric pendulum." Essential for students' work in frictional electricity, and desirable for many lecture table experiments in the subject.

The electroscope (which first employed the straw needle) was devised by Gilbert.

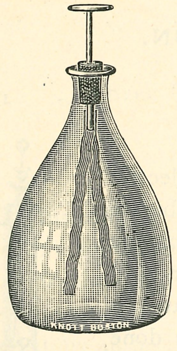

86-2

86-6 **Electro-static Indicator**, flask form, - - 1.00

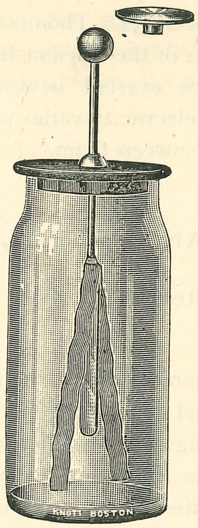
86-8 **Gold Leaf Electroscope**, with ball and plate top, 2.00

As described by Hall and Bergen, p. 485.

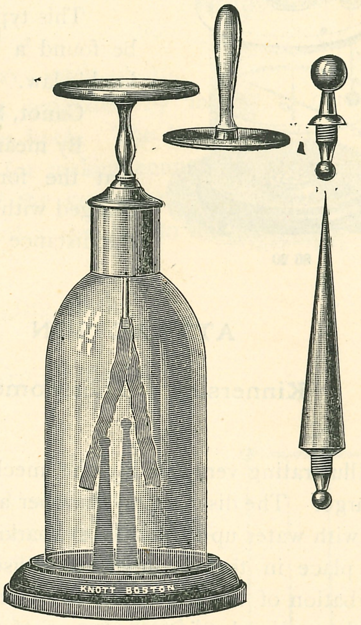
Made of Ritchie glass in simple form, but well adapted for determining the laws of the static charge. Provided with aluminum leaf because of its lightness and strength, its sensibility to the electric charge, and ease with which it may be replaced if broken.



86-6



86-8



86-12, 14, 16

86-12 **Gold Leaf Electrometer**, Bennett form, - - 4.50

This instrument has the base discharge, heavy construction, and is the standard for delicate lecture table work.

Provided with interchangeable ball and plate top.

Ganot, Sec. 751.

86-14 **Volta Condensing Plates**, for Bennett Electroscope, 2.50

A finely finished pair of condenser plates to fit the Bennett Electroscope, thus producing the most sensitive form of electroscope yet devised.

The bottom plate takes the place of the ball top while the upper plate has an insulated handle.

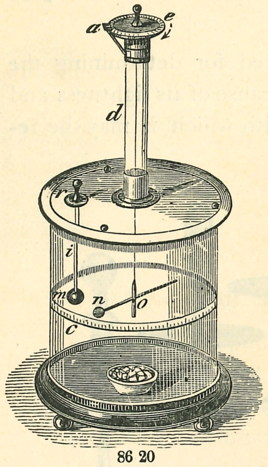
Ganot, Sec. 779.

86-16 **The Saussure Form of Condenser Plate and Point**, 2.00

Made to replace the ball on the Bennett Electroscope, showing the rapid discharge of the electroscope due to a point, the value of pointed lightning rods and the electrical condition of the atmosphere, foretelling thunder-storms.

Ganot, Sec. 993; Silvanus Thompson's Electricity, Sec. 47.

86-20 **Coulomb's Torsion Balance, or Electrometer,** 17.50



86 20

For studying the laws of electric force acting between two electrified bodies.

The quantity is measured by a delicate needle suspended in a long tube which points to a scale, graduated in degrees, and attached to the sides of a large glass cylinder.

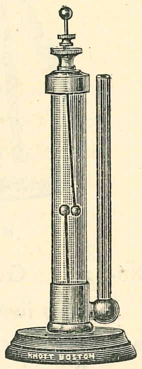
This type is after that designed by Coulomb and will be found a valuable instrument for the study of Coulomb's law.

Ganot, Sec. 734; Thompson, Sec. 18.

By means of the Torsion Balance it has been proven that the force exerted between two bodies statically charged with electricity varies inversely as the square of the distance between them.

ATTRACTION AND REPULSION.

86-24 **Kinnersley's Thermometer,** - - - - 14.00



86-24

Illustrating very forcibly the mechanical effects of an electric discharge. The discharging chamber and connecting index tube are filled with water up to the lower sparking knob. When a discharge takes place in the chamber, it causes a sudden expansion and perturbation of the air, which is indicated by the rise of water in the index tube, showing the reason for much of the damage done by lightning in passing into a closed building.

Ganot, Section 792, figure 691.

The apparatus is especially made for lecture table use, having thick glass tubes with brass mountings.

86-28 **Apparatus for piercing glass by high potential current,** 2.75

A unique and forcible illustration of the power of the high potential discharge.

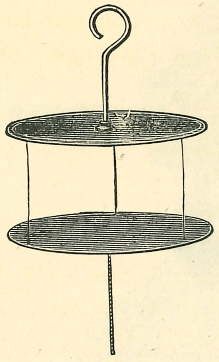
Connect the binding post of instrument to one pole of the generator and place the base of the instrument on the glass plate to be tested, the lower side of which is connected to one pole of the machine, a glass plate one-half inch in thickness may be readily punctured. A heavy coating of shellac on the plate renders the experiment much more satisfactory.

Ganot, Sec. 792.

The apparatus consists of a solid glass cylinder, broadened at the base and provided with a binding post at the top from which a fine copper wire extends, imbedded in the glass, to the outer surface of the base.

86-30 **Plates for Pith Images,** - - - - 1.50

86-32 **Pith Images,** per pair, - - - - .75



86-30

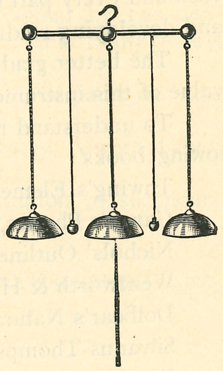
A striking method for illustrating and studying the phenomena of attraction and repulsion.

The plates may be suspended from the terminal of a static machine or conductor. The pith images are placed between the plates, which move up and down according as they become charged with the different kinds of electricity. Induction is here very clearly shown.

The plates are separated by insulating cords and suspended by a brass hook. The lower plate is provided with a brass chain for making connection to the ground, or opposite pole of the generator. The upper plate has a hook for being readily attached to the generator.

86-36 **Two Charging and Discharging Bells,** - - 1.25

86-40 **Three Charging and Discharging Bells,** - - 1.50



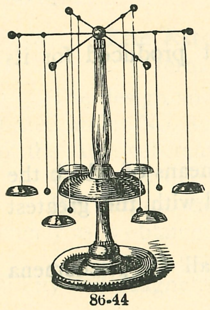
86-40

Illustrating electro-static attraction and repulsion.

This set permits of interesting experiments with the static machine, showing attraction and repulsion. The two outer bells are to be connected to one terminal, while the central bell is suspended by an insulating cord, but grounded or connected to the other terminal of the static machine. The attraction and repulsion of the small brass balls causes the bells to sound.

Ganot, Sec. 763.

86-44 **Electrical Chimes, set of seven, mounted,** - - 9.00



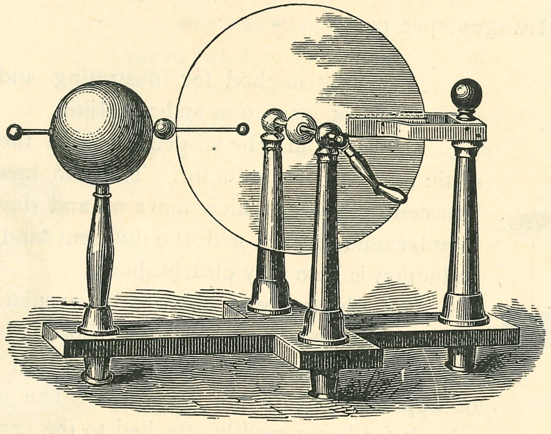
86-44

A striking illustration of electric attraction and repulsion between electrified bodies.

A handsomely mounted set of seven brass bells, nickel-plated, encircling a central bell. Between these bells are the vibrating balls.

For theory of action, see Silvanus Thompson, Sec. 46.

FRICTION AND INDUCTION GENERATORS.



87-2

87-2 E. S. Ritchie's Original Friction Machine, - 22.00

For teaching the fundamental principles of frictional electricity this machine has no equal. The current is generated solely by friction, induction having no part in its operation. The plates are of sufficient size and the construction so open that each and every part may be tested for polarity, and the entire process of charging and developing studied with scientific accuracy.

The better grade of secondary schools and colleges are again appreciating the value of this instrument, not as a toy but as an educational instrument.

To understand more clearly the present position of this machine, see the following books:

Thwing's Elementary Physics, p. 107.
Ganot's Physics, Sec. 753.
Nichols' Outlines of Physics, p. 226.
Wentworth & Hill, p. 278.
Dolbear's Natural Philosophy, p. 193.
Silvanus Thompson's Electricity and Magnetism, Sec. 40.
Deschanel, Part III, p. 32.

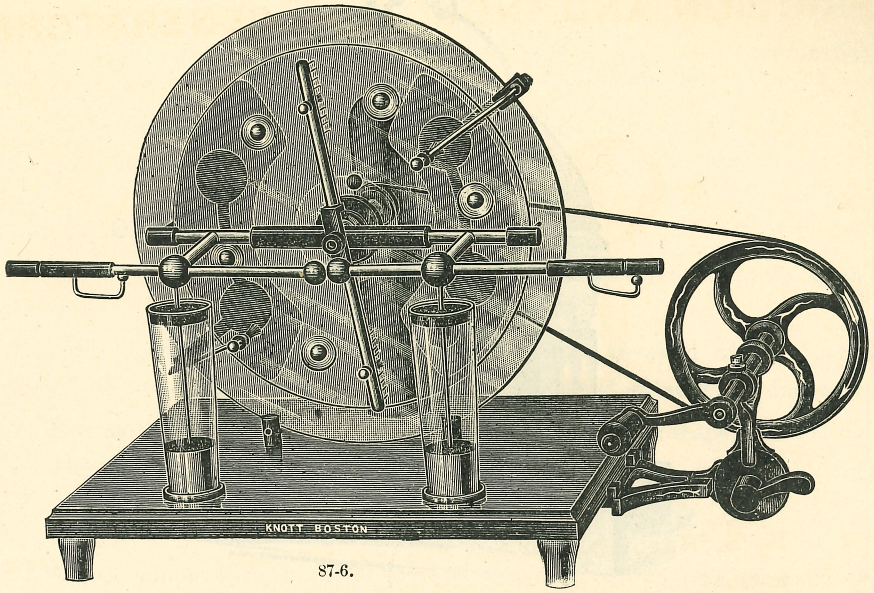
The friction machine in its present form represents the combined work of Otto Von Guericke, Newton, Winckler, Franklin and E. S. Ritchie.

For methods of caring for the friction machine, see Silvanus Thompson, Sec. 45.

(NOTE) The Ritchie glass is well known as the best yet produced for its electro-static generating and di-electric properties.

"Instruments called electrometers have been devised, by means of which the kind of electrification, and also its intensity, can be ascertained with the greatest ease and certainty." Wentworth & Hill, p. 277.

"It is wonderful to think how few are the powers by which all the phenomena of nature are governed." Faraday, 1859.



87-6.

87-6 Ritchie Static Electrical Machine of Toepler-Holtz Pattern, base 12 x 15 inches, price, - - - - 19.50

The design and construction of this machine has been developed by two generations of careful scientific work. We ask special attention to their many points of superiority. They charge quickly in all kinds of weather.

The glass plates are finely finished and perfectly balanced. All parts are supported rigidly in place and will not readily get out of adjustment.

Perfectly adapted to all work with Leyden Jars, Geissler Tubes, Aurora Tubes, Electric Chimes, etc. A most valuable educational instrument.

We can recommend these machines for X-ray demonstration in secondary schools.

Special Crookes tubes and fluoroscopes furnished if desired.

The theory of the Influence Machine is well explained in Thompson's Electricity, Sec. 49.

Gentlemen :—

The Holtz machine is working very satisfactory and I am much pleased with it.

Yours truly,
ARTHUR F. O'MALLEY, Gardner, Mass.

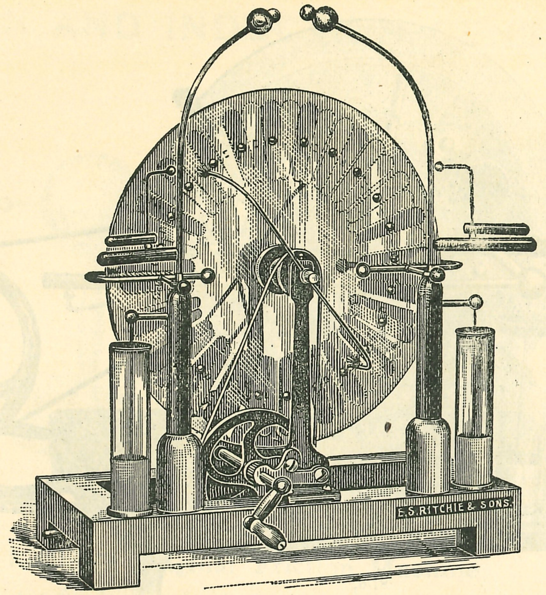
87-8 The Ritchie Static Electric Machine, Toepler-Holtz Pattern, 16-inch plate, price, - - - - - 38.50

The design and construction of this machine is much the same as that illustrated under No. 87-6, except the plates and entire machine is of larger design, but of the same substantial construction and much higher efficiency.

For X-ray demonstration this machine is superior to the smaller size.

We warrant the same careful adjustment of the parts with proportionate efficiency as is obtained in all of the Ritchie designs.

For a clear explanation of the Holtz machine, see Silvanus Thompson's Electricity and Magnetism, Sec. 49 to 53.


E. S. RITCHIE & SONS.

87-12.

87-12 **Wimshurst Machine**, price - - - - 32.00

A form of static generator preferred by some because of the rapidity of discharge obtained with it.

For a full discussion of the action of this machine see:
Elements of Physics by Nichols, Vol. II, p. 108.
Deschanel's Natural Philosophy, Part III, p. 36.

This type of machine consists essentially of two plates revolving in opposite direction with equal speed, and each carrying on its outer face an equal number of metal armatures.

The following table gives the voltage required to transmit a spark between two balls of given radius at varying distances apart; temperature being 15 degrees cg; pressure being 76 cm.

DISTANCE BETWEEN BALLS (Centims).

Radius of Balls.	0.1	0.5	1.0	1.5
Centims.	Volts.	Volts.	Volts.	Volts.
2.5	4,500	18,900	38,840	47,610
1.0	4,860	18,030	32,120	41,160
0.5	4,950	17,790	27,810	32,400
0.25	4,980	16,200	20,790	22,980

REPAIRS TO ELECTRICAL MACHINES.

Our repair department is well equipped for rendering prompt and reliable service.

We can furnish any of the material for the electrical machines of standard types, or make any part to order.

87-20 **Glass Plates.**

How to order—Send us diagrams and carefully stated measurements taken as follows:—

Place together the parts of the broken plate; draw an exact diagram indicating size of central hole, size and position of armatures and estimate the thickness.

For the Wimshurst plate give in addition to the above, the shape, size and number of the metallic sectors.

87-24 **Tin Foil.**

A good supply of tin foil is a valuable adjunct in all teaching of static electricity.

87-26 **Handles and Electrodes**, per pair, - - - - 1.50

Brass with flexible cord for attaching to electrical machine.

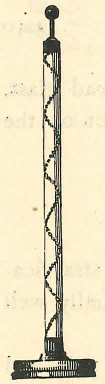
87-28 **Amalgam**, per bottle, - - - - - .25

We furnish amalgam freshly prepared for electrical or chemical work.

87-30 **Brass Chain**, per yard,

For connecting generators to Leyden Jar.

87-34 **Spiral Tubes**, 20 inches long, - - - - 2.00



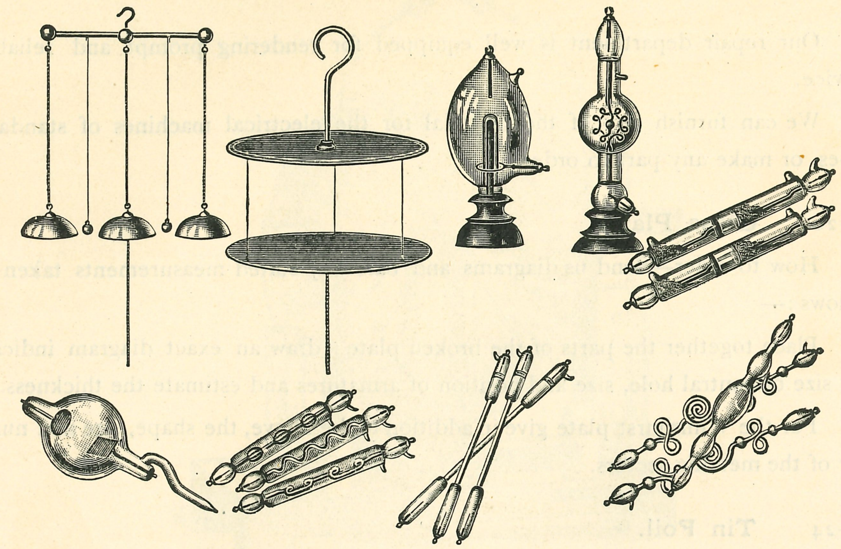
87-34

The upper end of the tube, provided with a ball electrode, is attached to one pole of the machine, the other end held in the hand. Sparks appear simultaneously at each interval and produce a luminous appearance, especially striking in the dark.

The surface of the tube is spotted spirally its entire length with tin foil discs. A wooden base is provided in which the tube may be placed when not in use.

Ganot, Sec. 789.

VACUUM DISCHARGE APPARATUS.

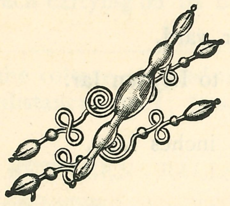


86-40.
89-2.
86–30.
88-26.
88-16.
88 20.
88-12.
88-28.
88-2.

GEISSLER TUBES.

Of the great variety of Geissler tubes which have been devised by the German glass blowers, only a few are of direct educational value. The selection which we offer has been made with the greatest care possible and will be appreciated by teachers lacking either time or facilities for making the choice for themselves.

All our tubes are made of heavy glass, the workmanship representing the highest skill of the glass blowers' art.



88-2 **Geissler Tubes,** set of 4, length 6 inches, per set, - 2.40

Filled with air highly attenuated. Pressure about 1-2 mm.

These tubes are made in a variety of designs of uranium, iron and lead glass, showing not only the effect of design on illumination, but also the effect on the kind of glass. The glass has a fluorescence as follows :—

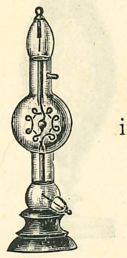
Uranium,	yellow
Iron,	green
Lead,	blue

When used with the induction coil a great variety of effects such as stratification, color, and fluorescence are presented. Many of these effects are equally well shown with the static machine.

A tube of rarefied air most frequently shows red light at the positive pole and violet at the negative pole.

88-8 **Large, Attractive, Demonstration, Geissler Tube,** 20 inches long, - - - - - - - 3.00

88-12 **Large, Attractive, Demonstration, Geissler Tube,** furnished with a stand, - - - - - - 3.00

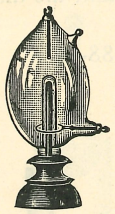


88 12

These tubes are made with a beautifully designed uranium spiral, in the bulb, of lime glass. A most attractive lecture table piece.

We publish a complete list of X-ray circulars.

88-16 **Geissler's Globe,** for illustrating the Rotation of Induced Currents, 5.00



88-16

An experiment devised by Plücker for showing the influence of a magnet on light in the Geissler tubes.

The globe is exhausted and provided with electrodes, which may be connected to an induction coil or static machine. The current sent through the tube forms into a single band or arc, having a spiral shape and moving slowly around the magnetized bar.

The experiment marks a very important step toward the answer to the question "What is Electricity? What is Magnetism?"

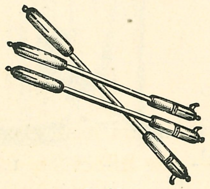
88-18 **Geissler Tube Rotator,** - - - - - 5.50

Made for attaching to the whirling table. A convenient and indispensable method of using Geissler tubes on the lecture table.

It is adjustable for tubes from 6 to 10 inches long.

The whirling table will be found the most satisfactory method of rotating Geissler tubes, because of the ease with which the speed may be regulated and the readiness with which it is set up for operation.

88-20 **Plücker's Spectrum Tubes,** each, - - - 2.00



88-20

These tubes are especially designed for use with the spectroscope and demonstrate the difference in the character of the light produced in a variety of gases. Use spectroscope listed in another section.

Tubes with the following list of residual gases are carried in stock :—

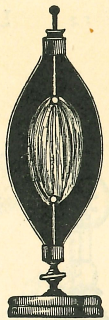
CO_2,	green
H_2O,	vapor, light pink
H,	cream yellow
N,	deep pink
O,	pale purple

This is the form best suited for comparison tubes in the spectroscopic analysis of the heavenly bodies, as first conducted by Huyghens and Miller.

Ganot, 578 and 579.

88-22 **Ritchie's Electric Globe with Stopcock.** (Electric Egg.) 7.50

For studying the phenomena of an electric discharge in a vacuum. It is arranged so that discharges may be sent through the globe while it is being exhausted on an air pump.


88-22

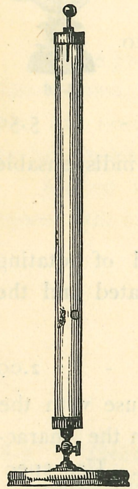
It consists of an ellipsoidal glass globe fitted with stopcock and screw for attaching to an air pump plate. The discharging terminals in the globe are connected to brass caps on each end, to which the lead wires are connected from an electrical machine. The upper terminal is adjustable so that the length of the discharge may be varied. The best effects will be produced with a rotary air pump.

This experiment bears an important relation to the study of Geissler and Crookes tubes.

Ganot, Sec. 788.

It shows that the character of the discharge depends on the degree of vacuum and the distance between the terminals.

88-24 **Combined Aurora and Guinea and Feather Tube,** 3 feet long, - - - - - - - - 7.00

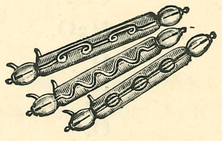

88-24

See Guinea and Feather tube.

Superior for showing in a striking manner the striae produced in any gas, its greater length and uniform size contributing to the more satisfactory results.

88-26 **Double Fluorescent Tubes,** 8 inches long, - - 1.80

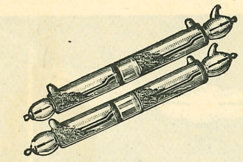
These are double tubes; the inner one being of a variety of shapes of uranium glass, the outer being filled with a fluorescent solution.


88-26

These serve to illustrate the very beautiful effect of fluorescence, as well as making a very attractive exhibition of the effect produced by an electric current on glass under reduced pressure.

These are made with solutions of Eosin, Quinine, etc.

88-28 **Phosphorescent Tubes,** - - - - - 1.50


88-28

This tube contains crystalline salts which phosphoresce under the action of an electric discharge, showing how radiant matter may produce visible light.

Dolbear's Natural Philosophy, pp. 184 and 186.

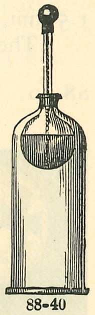
88-32 **Phosphorescent Mercury Tubes,** - - - - 2.20

The friction resulting from mercury falling on globules of glass produces a beautiful phosphorescent glow, especially striking in a darkened room.

A very suggestive experiment intimating the relation between electricity and light.

Ganot, Sec. 635.

88-40 **Abbe Nollet's Globe,** - - - - 6.75


88-40

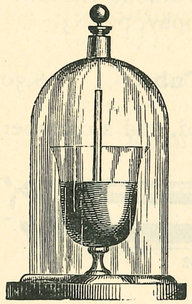
An attractive lecture table experiment showing fluoresence of a substance in either the solid or liquid form.

A capped receiver with thick glass globe arranged with removable top and connecting chain.

Especially desirable as a variety of substances may be tested under varying degrees of vacuum.

It was by means of this apparatus that the extensive experiments leading to the perfection of the fluoroscope were conducted.

88-42 **Luminous Jar,** or Gassiot's Cascade, without receiver, - 1.50


88-42

May be used with receiver 6x12 inches.

For showing the effect of atmospheric pressure on an electric discharge. At normal pressure the color of the spark is white and brilliant, but with reduced pressure it is diffused to a uniform glow.

Ganot, Sec. 786.

Place the jar under an air pump receiver having metallic connections through the top to the inner coating. The air pump plate then becomes the other terminal, causing the electricity to flow out over the sides and down to the plate resembling a cascade. This luminous effect is beautiful in a darkened room.

As considerable exhaustion is required to perform this experiment satisfactorily, it is recommended that the Rotary Air Pump be used.

Davidson, N. C.

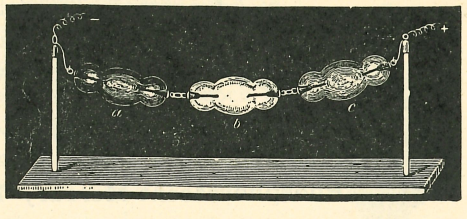
Gentlemen :—

The tube came a few days ago. I have just tested it and find it admirable. It has a remarkable penetrating power and acts vividly on the fluoroscope with the same apparatus which failed on other tubes.

Very truly yours,

Henry Louis Smith.

88-46 **Vacuum Tubes, with graded vacuum,** set of 6, - 9.00



88-46

Illustrating the relation between reduced atmospheric pressure and high potential electric discharges.

This set is made to show the stages of exhaustion and the resulting influence upon the electric discharge.

The air pressure varies from normal tension to that of nearly absolute vacuum, thus ranging by stages through the Geissler and Crookes vacuum.

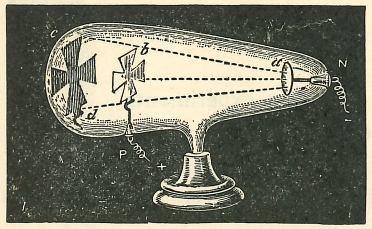
Each tube has independent platinum electrodes so that they may be used singly or in series.

A most valuable aid to the study of high vacuum leading to a correct understanding of the Crookes vacuum, as well as the method of "vacuum tube" lighting.

A carmine tint indicates a pressure of 62 mm.; salmon color, a pressure of 1.5 mm.; pale white, a pressure of 0.8 mm.

The greatest brilliancy of illumination is seen at a pressure of 0.379 mm.

88-50 **Tube with Maltese Cross** (Shadow Tube), - - 5.00



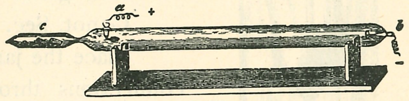
88-50

This is the form of tube used by Roentgen when X-ray effect was discovered.

The tube develops important facts relating to the direction of radiation, demonstrating that it travels in straight lines unless acted upon by some other force. The walls of the tube where the rays are strongest become highly fluorescent, the cross, however, casting a dark, sharply outlined shadow known as the "cathode shadow."
Dolbear's Natural Philosophy, p. 183.

88-52 **Crookes Adjustable Vacuum Demonstration Tube,** 8.50

A tube 12 inches long having platinum electrodes at each end, and a chamber attached for holding a vaporizing salt.



88-52

The air tension in the tube can be regulated by heating the chamber containing the compound. It is an excellent form for demonstrating the effect of pressure on electric discharges, showing also the principle of Geissler's tubes.

The vacuum may be made high or low at the will of the operator.

"In Crookes Tubes the variety of phenomena is very great, ranging, indeed, through a large part of physics." Dolbear.

Gentlemen :—

With the tubes and coil of your make I have obtained better results than any that I had previously taken (with nine months' practice), or better than I have ever seen and far better than I had anticipated.

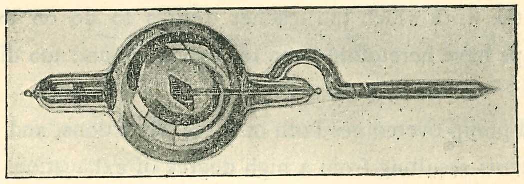
Yours truly,
A. H. Arp, M. D.
Moline, Ill.

X-RAY APPARATUS.

CROOKES TUBES FOR X-RAY WORK.

Our department for the manufacture of X-ray tubes merits the reputation which it has attained. We had the honor of producing the first tube made in this country by which a radiograph was taken, and our efforts to improve the product have been unceasing.

The early researches of Prof. John Trowbridge of Cambridge, which advanced to such an extent the knowledge of the possibilities of the practical application of X-ray work, was done with tubes of our manufacture.



X-ray Tube

We at once recognized the fact that the best results can only be obtained by frequent testing during exhaustion on the kind of generator which the tube is later to be used. This insures not only powerful X-radiation, but long life and uniformity of action.

Discovery published, Nov. 28, 1895.
Cable information to Associated Press, Jan. 7, 1896.
First picture taken with tube of our manufacture, Jan. 27, 1896.

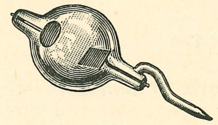
I have tested the Crookes tubes as manufactured by the L. E. Knott Apparatus Company and find them well exhausted and serviceable for photographing with the X-rays.

Prof. J. Trowbridge,
Jan. 28, 1896. Jefferson Physical Laboratory,
Cambridge, Mass.

89-2 **Single Focus Tube for Static Machine,** - 5.00 to 8.00
Depending on the size of the generator used.

89-6 **Focus Tubes for Induction Coil,** - - 6.00 to 10.00
Price varying with the length of spark and the make of coil.

89-10 **Focus Tubes for High Frequency Coil,** - 6.00 to 12.00



89-2

The adjustable vacuum attachment may, with advantage, be placed on all tubes if desired, except those to be used on static machines.

Gentlemen :—

The Crookes tubes which you sent me seem particularly well adapted for my coil, and give better results than I have ever obtained before, and I have used many tubes made by manufacturers both in this country and Europe.

Yours truly,
E. B. Stevens.
Buffalo, N. Y.

Gentlemen :—

I have examined the tube and found it such a good thing that I am keeping it in spite of half a dozen others on hand.

Yours truly,
I. N. Keyser.
Urbana, Ohio.

THE BOLTWOOD PUMP.

89-20 **Boltwood Pump,** complete, mounted on finished supporting stand, - - - - - - - 7.50

89-24 **Boltwood Pump,** complete, without stand, - - 6.00

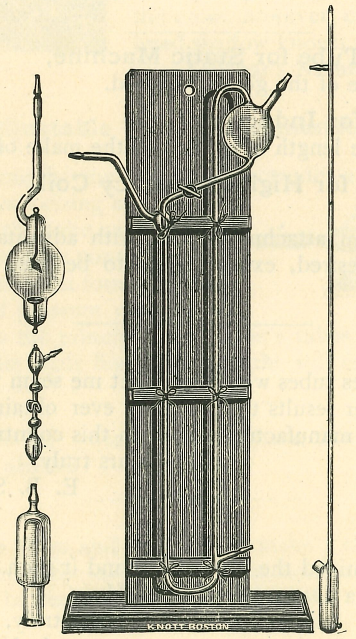
The limit of exhaustion possible with the cheaper forms of mechanical pump is too easily reached for much of the work which the teacher desires to do on the lecture table. The mercury pumps have heretofore been too expensive and too difficult of manipulation.

The Knott form of Boltwood pump overcomes both of these objections, and a most interesting series of experiments resulting from a high degree of exhaustion is made possible to almost any school.

The pump is operated continuously by a small aspirator.

It uses only a small amount of mercury and will exhaust a liter flask to an X-ray vacuum in twenty-five minutes.

Essential for experiments calling for a degree of exhaustion approaching the absolute vacuum.



89-20

List of Accessory Apparatus designed for use with the Boltwood Pump.

89-30 **Dewar Bulb,** - - - - - - 2.50

Rendered an especially valuable instrument because of the recent interest in liquid air. By it liquid air, or liquid carbon dioxide, is retained in the liquid form for a long time.

This is furnished tipped but unexhausted, ready to be connected to the pump.

89-36 **Small Crookes Tube,** reflector type, - - 2.50

Unexhausted, but tipped ready to be attached to the pump.

Complete directions for exhausting and testing the same is found in Thompson "On the X-ray."

89-40 **Barometer Tube** with reservoir and platinum electrode, 2.50

This apparatus is designed to show the resistance which a column of air offers to the passage of a high potential current, showing that the resistance varies with the air tension.

The instrument is quickly set up and easily operated.

A degree of exhaustion is soon reached where the electrical discharge, instead of being a spark, begins to show the brush effect and later the glow characteristic of the Geissler vacuum.

The tube is easily carried through all the stages of exhaustion to the point where the current fails to pass. The exact tension of each of these stages is quickly and easily determined by the height of the mercury column at that particular time.

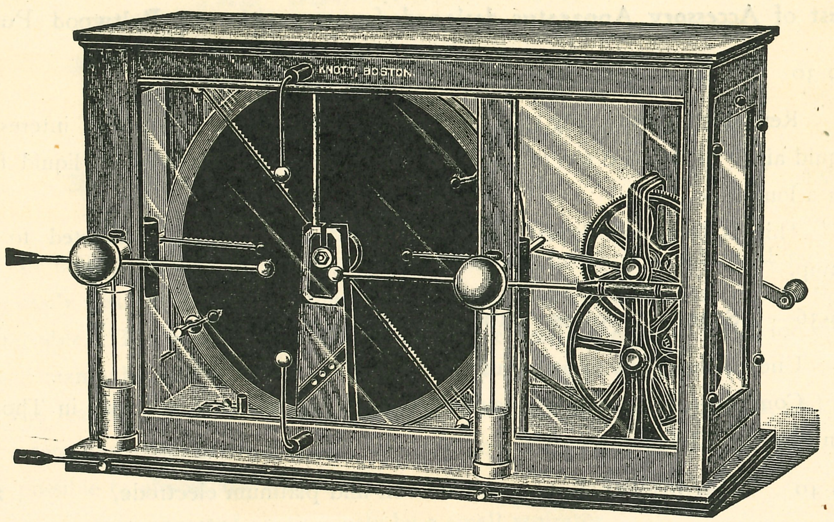
Nichols' Outlines, Sec. 228.

89-44 **Demonstration Geissler Tube,** - - - 1.10

A completed tube, but not exhausted, tipped ready to be attached to the pump.

"The **recitation** should be mainly by topics, with free use of the text-book and reference library. A judicious and regular use of some good text-book seems almost indispensable to the best work in teaching elementary physics. When a definite lesson is assigned from a text-book (as perhaps is desirable with the majority of classes in secondary schools) it should not be done in the old ' page by page' way, but rather ' topic by topic'."

Eastern Association of Physics Teachers.



89-52

Influence Machine of Modified Tœpler-Holtz Design.

89-50 **L. E. Knott Apparatus Co., Influence Machine, 4 plate,** 75.00

89-52 **L. E. Knott Apparatus Co., Influence Machine, 8 plate,** 125.00

This machine meets the demand for a powerful X-ray generator giving a much greater output both in frequency and quantity of discharge than the conventional form of Tœpler-Holtz machine. The rubber plates are easily rotated at 2,000 revolutions per minute. The result is a volume, frequency, and length of discharge equal to the most rigorous X-ray demands.

In addition to X-ray work this machine may be used to demonstrate all of the static high potential phenomena. For more complete information see Circular 48.

The success of this machine depends on the character of the generating plates and the almost perfect protection from atmospheric changes. Being designed for Hospital and Physicians' use, it is beautifully constructed in every particular.

Grand Island, Neb.

Gentlemen :—

I have been waiting until I was fully prepared, from actual experience, to decide upon the worth of your static machine. I have compared it with all of the best varieties in the market and it is my opinion that it possesses features which place it above everything else at present.

Yours very truly,

Geo. D. Sitzer, M. D.

Dear Sir :—

The Influence Machine works splendidly.

Sincerely,

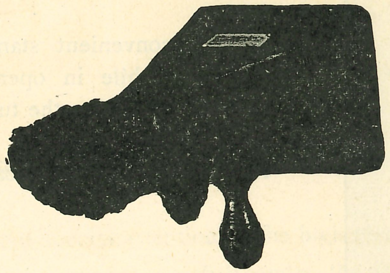
Will G. Hormell.

Ohio Wesleyan University,
Delaware, O.

89·60 **Fluoroscopes.** Per square inch of screen surface, - .35

89-60 Surface 3½ inches by 3¾ inches.
89-62 " 4⅞ " " 7¼ "
89-64 " 7¼ " " 9½ "

We carry only the best platinum screens noted for their superior illumination and definition. A poor screen is high at any price. The prices quoted include the mounting and hood.



89-60

Quotations from those who have used the L. E. Knott Apparatus Co. X-Ray Apparatus.

The fluoroscope came in good order and is very satisfactory.

A. W. Wright, Yale University.

I have used your eight plate Influence Machine for X-ray work for the past two months and am more than pleased with the results. I have had several outfits before, and this easily surpasses them all.

E. J. Powers, Danvers, Mass.

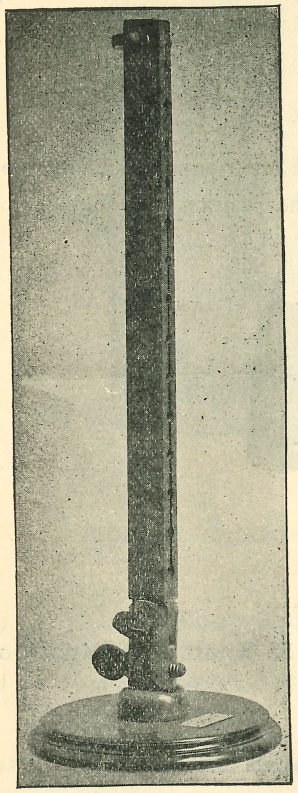
I am surprised at the results obtained from the static machine.

J. L. McDonald, Wellsville, Ohio.

It is the most powerful X-ray machine I have ever seen, and we are getting better results than from any other induction coil I have ever used.

J. H. Guinn, M. D., Arkansas City, Ark.

89-70 **Tube Holder,** - - - - - 2.00



89-70

A very convenient stand for supporting the Crookes Tube while in operation. Greatly lessens the liability of breaking the tube, and permits it being held in any desired position.

Adjusts in either a vertical or horizontal plane.

108 East 23d St., New York, N. Y.

Gentlemen :—Your tube holder No. 89-70 is the best that has ever been put on the market.

Henry E. Waite, M. D., Pres. Waite & Bartlett Mfg. Co.

The goods were unpacked yesterday; we are very much pleased, not only with the goods, but with the whole transaction, which will not be the last between us.

I. L. Cavanaugh, Loyola College, Montreal, Canada.

I hope to make orders soon between your house, with whom my dealings have been so satisfactory.

Prof. Chas. Winston, Richmond College, Richmond, Va.

We thank you very much for the great favor. We will continue to purchase material from you as it gives us excellent satisfaction.

H. R. Bierly, State Seminary, Tallahassee, Florida.

I thank you very much for your promptness and your business-like way of treating teachers. The apparatus has thus far given splendid results; I ask for no better.

Robert A. Bright, High School, Paterson, N. J.

The goods are highly satisfactory. We appreciate the courtesy with which our order was attended to.

I. B. McMillan, Canal Dover, O.

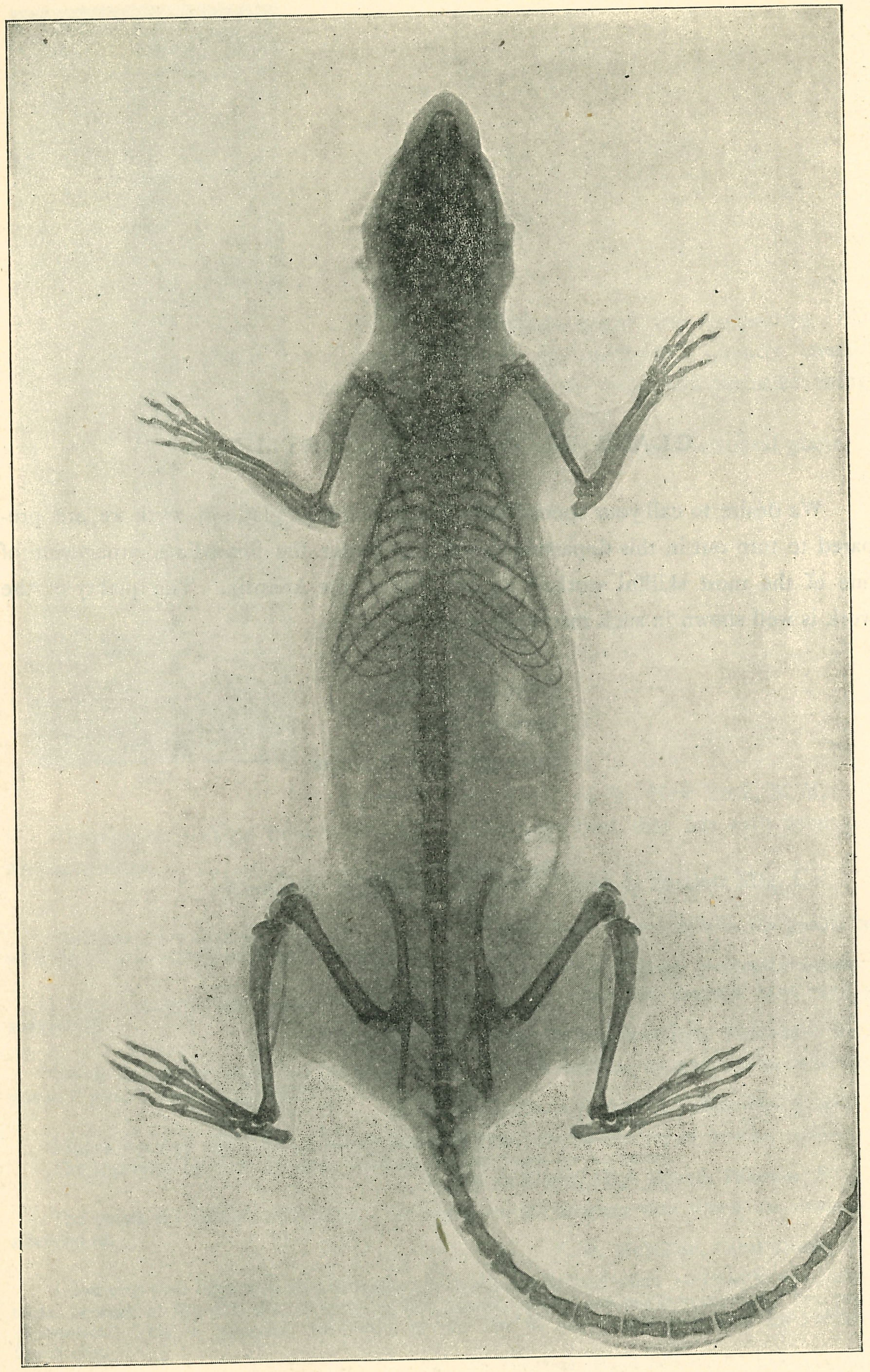
I find with your apparatus on electricity, that experiments heretofore confined to the lecture-table, because of the difficulty of securing the desired results, are easily secured by the pupils themselves. This is especially noticeable in the case of the simple apparatus for Frictional Electricity.

H. P. Reynolds, High School, El Paso, Texas.

GLASS BLOWING DEPARTMENT.

We desire to call your special attention to the high grade of work we are prepared to turn out in this department, which is under the immediate supervision of one of the most skillful workers on this side of the Atlantic. The quality of the work is well shown in such instruments as

Crookes Tubes
Dewar Bulbs
Sprengel Air Pumps
Boltwood Pumps
Thermometers
Barometers, etc.



L. E. Knott Apparatus Co., Boston, Mass.